MODIS Atmospheric Profiles

Product Description

The MODIS Atmospheric Properties (MOD 07 at Level 2 and MOD 08 at Level 3) consists of several parameters; they are Total Ozone Burden, Atmospheric Stability, Temperature and Moisture Profiles, and Atmospheric Water Vapor. All of these parameters are produced day and night for Level 2 at 5 x 5 1-km pixel resolution when at least 9 FOVs are cloud free; for Level 3, data are generated on a 0.5° latitude/longitude resolution grid daily, monthly, and seasonally.

The MODIS Total Ozone Burden is an estimate of the total column tropospheric and stratospheric ozone content. The MODIS Atmospheric Stability consists of three daily Level 2 and monthly Level 3 atmospheric stability indices. The Total Totals (TT), the Lifted Index (LI), and the K index (K) are each computed using the infrared temperature and moisture profile data also derived as part of MOD 07. The MODIS Temperature and Moisture Profiles are produced at 20 vertical levels for temperature and 15 levels for moisture. A simultaneous direct physical solution to the infrared radiative transfer equation in a cloudless sky is used. The MODIS Atmospheric Water Vapor product is an estimate of the total tropospheric column water vapor made from integrated MODIS infrared retrievals of atmospheric moisture profiles in clear scenes.

Research & Applications

Total column ozone estimates at MODIS resolution are required by MODIS investigators developing atmospheric correction algorithms. This information is crucial for accurate land and ocean surface parameter retrievals. Furthermore, strong correlations have been found to exist between the meridional gradient of total ozone and the wind velocity at tropopause levels, providing the potential to predict the position and intensity of jet streams. Total column ozone monitoring is also important due to the potential harm to the environment caused by anthropogenic ozone depletion.

Atmospheric instability measurements are predictors of convective cloud formation and precipitation. The MODIS instrument offers an opportunity to characterize gradients of atmospheric stability at high resolution and greater coverage. Radiosonde-derived stability indices are limited by the coarse spacing of the point source data too large to pinpoint local regions of probable convection.

MOD 07, MOD 08
PRODUCT SUMMARY

Coverage:

global, clear-sky only

Spatial/Temporal Characteristics:

5 km (Level 2), 0.5° (Level 3)/daily, monthly

Key Science Applications:

for ozone: atmospheric correction, prediction of cyclogenesis, anthropogenic ozone depletion

for atmospheric stability: atmospheric correction, prediction of convective cloudiness and precipitation, characterization of the atmosphere

for soundings: atmospheric correction algorithm development and use, characterization of the atmosphere

for total column water vapor: atmospheric correction algorithm development and use, characterization of the atmosphere

Key Geophysical Parameters:

total column ozone, atmospheric stability (Total Totals, Lifted Index, and K index), atmospheric profiles of temperature and moisture, atmospheric total column water vapor

Processing Level:

2, 3

Product Type:

standard, routine

Science Team Contact:

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MODIS Atmospheric Profiles

Atmospheric temperature and moisture sounding data at high spatial resolution from MODIS and high spectral resolution sounding data from AIRS will provide a wealth of new information on atmospheric structure in clear skies. The profiles will be used to correct for atmospheric effects for some of the MODIS products (e.g., sea surface and land surface temperatures, ocean aerosol properties, water leaving radiances, and PAR) as well as to characterize the atmosphere for global greenhouse studies.

Total column precipitable water estimates at MODIS resolution are required by MODIS investigators developing atmospheric correction algorithms. This information is crucial for accurate land and ocean surface parameter retrievals. MODIS will also provide finer horizontal scale atmospheric water vapor gradient estimates than are currently available from the POES.

Data Set Evolution

One of two ozone retrieval methods developed using the HIRS will be chosen as best suited for application with MODIS data. Both use a first guess perturbation method and radiances from MODIS channel 30 (9.6 μm) to solve the radiative transfer equation. The perturbations are with respect to some *a priori* conditions that may be estimated from climatology, regression, or more commonly from an analysis or forecast provided by a numerical model. The MODIS cloud mask product (MOD 35) will also be used to screen for clouds.

Atmospheric stability estimates will be derived from the MODIS temperature and moisture retrievals contained in product MOD 07. Layer temperature and moisture values may be used to estimate the temperature lapse rate of the lower troposphere and the low-level moisture concentration.

Temperature and moisture profile retrieval algorithms are adapted from the International TOVS Processing Package (ITPP), taking into account MODIS' lack of stratospheric channels and far higher horizontal resolution. The profile retrieval algorithm requires calibrated, navigated, and coregistered 1-km FOV radiances from MODIS channels 20, 22-25, 27-29, and 30-36. The MODIS cloud mask (MOD 35) is used for cloud screening. The algorithm also requires NCEP model analyses of temperature and moisture profiles as a first guess and an NCEP analysis of surface temperature and pressure.

Several algorithms for determining atmospheric water vapor, or precipitable water, exist. It is most directly achieved by integrating the moisture profile through the atmospheric column. Other split window methods also exist. This class of techniques uses the difference in water-vapor absorption that exists between channel 31 (11 μm) and channel 32 (12 μm).

Data validation will be conducted by comparing results to *in situ* radiosonde measurements, NOAA HIRS operational retrievals, GOES sounder operational retrievals, NCEP analyses, and retrievals from the AIRS instrument on the PM platform. A field campaign using a profiler network in the central U.S. and the MAS-equipped aircraft will be initiated in the first year after launch. Quality control will consist of manual and automatic inspections, with regional and global mean temperatures at 300, 500, and 700 hPa monitored weekly, along with 700 hPa dew point temperatures. For total ozone, data validation will consist of comparing the TOMS as well as operational NOAA ozone estimates from HIRS to the MODIS retrievals.

Suggested Reading

Hayden, C.M., 1988.

Houghton, J.T., *et al.*, 1984.

Jedlovec, G.J., 1987.

Kleepsies, T.J. and L.M. McMillan, 1984.

Ma, X.L., *et al.*, 1984.

Prabhakara, C., *et al.*, 1970.

Shapiro, M.A., *et al.*, 1982.

Smith, W.L. and F.X. Zhou, 1982.

Smith, W.L., *et al.*, 1985.

Sullivan, J. *et al.*, 1993.

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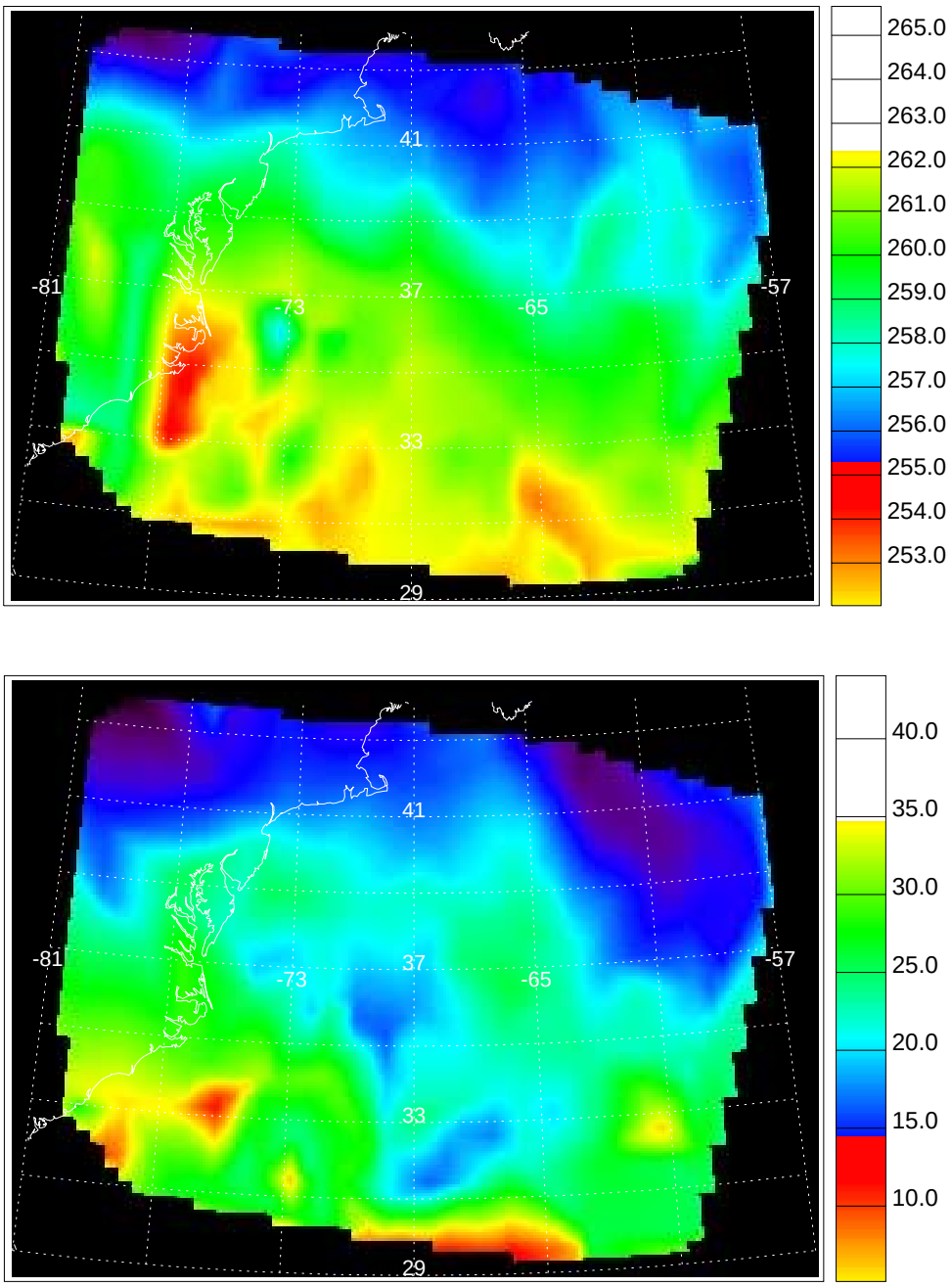

Figure 28. **MODIS Atmospheric Profiles**. *Level 2 MODIS atmospheric properties generated by the International TOVS Processing Package (ITPP) using NOAA-12 HIRS data acquired on 15 May 1995 at 12:12 UTC. The upper panel represents temperature at 500 hPa (K), whereas the lower panel represents total precipitable water (mm).*